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ABSTRACT

This study discusses the nature of rhythm as it may apply to speech and language, reviews some of the literature on the development of rhythm, and presents some thoughts relating these findings to specific examples of children's speech. There is evidence to support the view that one need not look at the exact rhythm of any utterance, but only for sequential organizing principles that children must recognize are at work in the language and then see how they go about learning these principles. Vanderslice and Ladefoged's study of English prosody leads to the notion that the single most important rhythmic phenomenon in English is the distinction between stressed and unstressed vowels. While the small amount of research on the development of stress, rhythm and segment-timing in children's speech reveals some inconsistencies, it leads to some tentative conclusions. Children appear to produce durational and other prosodic differences as early as 18 to 24 months, but their productions are characteristically variable until much later, stabilizing to adult norms around age ten. In conclusion, examples of children's utterances illustrate some rhythmic phenomena of interest, namely, examples of the correct or incorrect reduction of light syllables, examples of deletion of whole syllables, and samples of doubling or extreme lengthening of phrase-final syllables. (AMH)

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DEVELOPMENT OF RHYTHM IN EARLY PHONOLOGY*

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What we presently know about the development of rhythm in children's phonology can be writ large on the head of a pin. One finds occasional mention of rhythm in the developmental psycholinguistic literature, but no real data. In this paper I would like first to discuss the nature of rhythm, especially as it may apply to speech and language, then to review briefly some of the published findings that relate to the development of rhythm, and then to present my most recent, as yet very sketchy, thoughts on how we might best view the subject, along with some examples which illustrate various phenomena of interest.

First, on the nature of rhythm in speech and language, I think it is important to take some time with this topic, since there is much room for misunderstanding. When "rhythm" is mentioned, some think of metrical feet, such as iambs, trochees, dactyls, and the like, and images of "Arma virumque cano," or "Break, break, break...," or even "Hickory, dickory, dock" come to mind. Others think of temporal rhythm, that is, how many milliseconds are there between the successive stressed syllables in the phrase, and is it "stress timed" or "syllable timed" as a result. But although both the perceived meter and the temporal figure of a sentence are two very important aspects of rhythm in speech and language, and, for that matter, in poetry, there are many other phenomena which help to define our total rhythmic feeling, such as the repetitions of words, sounds, or grammatical structures, the relationships of word and grammatical boundaries to naturally defined metrical boundaries, and the accent pattern of each word that is actually chosen from a number of possibilities. In other words, any phenomenon that plays a role in the sequential structure of an utterance is a potential shaper of the rhythm, which I therefore define as the pattern of a sequence in language or speech.

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Now "pattern of a sequence" is too broad to be of much help in beginning to study children's development of phonological rhythm, and eventually I shall have to get much more specific. But I think it is important to recognize the very breadth of rhythmic phenomena, since I feel that this characteristic has been the reason why speech rhythm is so poorly understood at this time. For any given sentence that anyone wishes to analyze, there are just too many structures of potential

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importance to the rhythm, be they phonological, syntactic, or semantic, and the analysis quickly complicates beyond comprehension. We require some simplifying principles that will help us to know what is most important and when, and, for my present purposes, what is most important in the speech and language of the child.

In a recent article (Allen, 1975) I have tried to tie speech production and perception to other motor and perceptual behavior, the rhythmic organization of which has been studied. My major conclusion is that, although there are well known rhythmic organizing principles at work in any motor behavior, and although these principles are probably at work in the historical development of language, the adult native speaker has no use for them, since his language is already rhythmically structured for him; that is, the phonological output is made to be spoken, and he needs to impose no further rhythmic structure on it than it already has. Then the listener, possessed as he is of strong perceptual rhythmic biases, imposes structures on the speech that probably aren't there in any physical sense, but which convince him that what he hears is very rhythmic.

The reader may refer to the 1975 article for the evidence that leads me to this view that languages are "made to be spoken"; let me give just one example. Motor behavior is strongly constrained into the simplest sequential patterns, either successions of like events, or alternation of strong and weak events. Any grammatical rule which yields an output conforming to such a simple sequence will therefore help the speaker. One such phonological rule in English is the well documented alternating stress rule (Chomsky and Halle, 1968) which predicts an alternation of strong and weak syllables in polysyllabic words; perhaps less obvious, but I believe equally important in English, is the myriad of syntactic rules which yield one or two function words--usually short, weak, or monosyllabic--between successive content words, which are longer and usually strongly accented. As a result of these two kinds of rules, one phonological, the other syntactic, English sentences typically alternate accented and unaccented syllables, giving rise to the stress rhythm which we feel characterizes our language.

Now because I feel that (1) the rules of our language constrain its output in such a way that little or no further rhythmic adjustment is required during speech production, and (2) the listener imposes additional rhythmic structure on what he hears, I believe that we need not look at the exact rhythm of any utterance, whatever the term "exact rhythm" might mean, but rather we need only look for the sequential organizing principles that each child must recognize are at work in his language and see how he goes about learning them.

The single most important rhythmic phenomenon in English is, I believe, the distinction between stressed and unstressed syllables; that is therefore where my study of the development of phonological rhythm has begun. I must say, however, how important Vanderslice and Ladefoged's (1972) reworking of English prosody into a few binary features has been to the germination of my thoughts. Their feature system, outlined briefly in Table I, divides accentual, intonational, and emphatic phenomena into six features. This paper is concerned primarily with

just the first two, although the extra length assigned to intonation bearing syllables will be noted.

Table 1. Principle Grammar-Expounding Prosodic Features of English*

Feature Name	Comments	Phonetic Correlates
± HEAVY	A light syllable is "unstressed" and of briefer duration (cet. par.) than a heavy one.	Full articulations vs. reduced timing.
± ACCENT	An accented syllable corresponds roughly to IPA primary stress.	Presence vs. absence of increased respiratory energy and laryngeal adjustment, causing a pitch obtrusion.
± INTONATION	Abstract feature assigned to nuclear accented syllable, implying a plus value of one or both of the following features.	None.
± CADENCE	Affects the post-nuclear portion of a sense group.	Presence vs. absence of a low (usually falling) pitch pattern.
± END GLIDE	Affects either the whole post-nuclear portion of a sense group, or (with [+cadence] only the terminal portion.	Presence vs. absence of a rising pitch pattern.
± EMPHASIS	Subsumes Trager-Smith's pitch 4 and Halliday's tone 5.	Extra large pitch obtrusion on an accented heavy/syllable.

*From: Vanderslice and Ladefoged (1972).

Consider now just the first two features, ±HEAVY and ±ACCENT. Weight has to do with the tempo and quality of the articulations, +HEAVY syllables getting full articulation, -HEAVY, or light ones becoming reduced, often with short, centralized vowels and very brief consonants. To be +ACCENT, however, a syllable must receive a "pitch obtrusion" in Vanderslice and Ladefoged's terms--that is, an upwards or downwards change in fundamental frequency, perhaps accompanied by extra respiratory effort. Only +HEAVY syllables can also be +ACCENT, so that there are just three kinds of syllables in English, accented syllables, which are redundantly heavy, light syllables, which are redundantly unaccented, and heavy unaccented syllables. For example, in the word "citation", the first two syllables have full articulation, and are therefore +HEAVY, whereas the last is -HEAVY, or light; only the second syllable is +ACCENT, however, since that is where the pitch changes. Another example, the word "absolutely", shows that although the first and third syllables ("ab-" and "-lute-") are +HEAVY, the choice of which of these to accent may depend upon context, as in "absolutely famished",

which accents the first, "...corrupts absolutely", which accents the third, "absolutely gone", which accents both first and third, and "She's absolutely nowhere", which accents neither.

It may not be immediately apparent what advantage this system of description offers over, say, the Trager-Smith (1951) or Chomsky-Halle (1968) systems, but if you have ever tried to actually transcribe a text using those systems you know how dependent they are on knowledge of the phonological, syntactic, and semantic context of each syllable. These new features, on the other hand, tie the prosodies to physiological and acoustic features of the speech in an intuitively straightforward way, permitting one to approach each syllable much more on its own merits. I therefore believe that these features describe some of the rhythmically most important phonological constraints which learners of English must internalize.

Now let me review very briefly what is known about the development of prosody in children's speech. As noted earlier, virtually nothing has been written about children's speech rhythm, per se, but since a number of other phenomena, such as accent and segment duration, are important components of rhythm and have been studied, there are a few additional biases we can get from past work.

Concerning prosodic information in general, Weir suggested in 1966 that some language specific prosodic changes occur within the first year, but her claim must be balanced by the findings of Tervoort (1967) and of Atkinson, MacWhinney and Stoel (1969) that adult subjects could not reliably differentiate the sociolinguistic background of one-year-olds using this information. There are many published studies along these lines, but they all share two defects that prevent us from learning much from them: first, the decision as to whether or not a child used a prosodic distinction was based on the adult's phonologically biased perceptions; and second, the presence of a small number of correct uses constituted evidence that the child controlled the distinction, regardless of how many incorrect uses also occurred.

The use of stress-accent by children has been studied with some care. For example, studies by Risley and Reynolds (1970) and by Blasdell and Jensen (1970) showed that children pay more attention to accented words, and their earliest spoken output is likely to contain reduplicated forms which are prosodically two heavy syllables, the first of which is accented. Eilers, on the other hand, pitted the suprasegmental cues of pitch, intensity, and duration against semanticity and word order in a sentence imitation task and found that only the semantic and word order changes produced statistically different performance. This apparent contradiction with earlier studies on the importance of stress-accent in children's speech perception should be qualified in two ways, however, by referring to Table II (Table III of her study), which is reproduced here.

First, note that the sentences lacking suprasegmental cues (Treatment II) were, in fact, imitated more poorly than the controls. Second, and most interesting from the point of view of the present paper, if

Table II: Correctly Imitated Content and Function Words Summed Over Subjects

Word Type	Treatment Group*					
	I	II	III	IV	V	VI
Content[a]	152	136	155	126	137	123
Function[b]	75	48	74	58	61	55

[a] Total possible 174; [b] Total possible 120.

* I: Normal control sentences.

II: Pitch, intensity and duration constant.

III: Pitch and intensity constant, duration normal.

IV: Nonsense word substituted for one content word.

V: Function words in random order, content words correct.

VI: Content and function words in random order.

From: Eilers (1975)

only the pitch and intensity were altered, leaving the syllable durations normal (Treatment III), there was no decrement in performance. The observed difference goes beyond mere numbers here, moreover, since Eilers writes: "These trends...were reflected by the difficulty the experimenter had in obtaining imitations in treatment II and the relative ease of persuading children to imitate treatment III type sentences." Apparently her young subjects were quite aware of the durational constraints of the sentences, that is, their temporal rhythm, though it is not clear whether the children's difficulties resulted from perceptual or production problems, or both.

Another rhythmically related phonological process that has been noted by many observers of children learning English is the following: in forming reduplicated structures from polysyllabic adult words, initial light syllables are usually ignored, whereas post-nuclear light syllables may or may not be. For example, Smith's (1973) son Amahl, at age 2;2, produced /wei/ for "away", /ba:n / for "banana", and /ge:p/ for "escape". Such a process gives some validation of our feeling that English is a "trochaic" language, that is, characterized metrically by falling accent. The exact process involved here needs careful study however, since the rule is apparently not universal among children, and some of the attested forms contain segmental traces of the supposedly omitted initial weak syllable, for example Amahl's /ba:n /, with the initial /b/ of "ba-". In other words, although the rhythmic form of children's early polysyllabic words may be described by a few simple rules, the process

by which an individual child adapts any given adult word to his own system may be more complex, involving not only the word's stress pattern but also such features as the relative salience of its consonants (Waterson, 1971).

Finally, there are a number of studies that have examined the development of segment durations in children's speech, with results that fairly well agree that children appear to be sensitive quite early, by about age two, to distinctions in voice onset time and vowel durations before voiced vs. voiceless consonants, but that they cannot control these distinctions fully in their own vocal productions until much later, say about age ten.

Summarizing this very brief review of studies on the development of stress, rhythm, and segment timing, then, children appear to produce durational and other prosodic differences as early as 18 to 24 months, but their productions are characteristically variable until much later, stabilizing to adult norms around age ten.

Finally, Table III shows some examples of children's utterances which illustrate some rhythmic phenomena of interest. First will be some examples (1-7) of the correct or incorrect reduction of light syllables, then some examples (8-12) of deletion of whole syllables, and finally examples (13-15) of doubling or extreme lengthening of phrase final syllables, presumably to accommodate the cadence contour.

Table III: Illustrative Examples

Reduction of light syllables:

1. pirate dog → [ˈpʰaɪˈwʌt dɔd]
2. microphone → [ˈmaɪsɹɑɪsoʷn]
3. Sesame Street → [ˈsɛsəmi stɹit]
4. electric → [əˈlɛktɹɪk]
5. electricity → [lɛksˈtɹɪsəti]
6. hear it again → [ˈhiɹ ɪt əˈgɪn]
7. I sprang from the bed to see what's the matter →
   [aɪ ˈspwæŋ fwʌm ðə ˈbɛd/tuˈsi wʌts əˈmæɾə]

Deletion and coalescence of light syllables:

8. Hairy Monster and Grover → [ˈhæwi ˈmanstən ˈgwoʷvə]
9. Donner and Blitzen → [ˈdanɚ ˈbɪɪtsən]
10. Somebody starts opening it → [ˈsʌmbəˈ stats ˈopɪŋ ɪt]
11. sandwiches → [ˈsæ̃nwɪʧəz]
12. tuna sandwiches and... → [ˈtʰunə ˈsæ̃ʃæ̃ː]

Phrase-final vowel lengthening

13. it goes around and around → [əˈwaʔʷn əɲəˈwaʔʷːn]
14. He's a dog/.../A pirate dog → [ˈdɔɔd/.../ˈpʰaɪwʌt dɔd]
15. See all the paint coming off... → [...ɔf]

First, let us consider the examples involving light syllables. In example I, the second syllable of "pirate" should be, but is not, reduced. The child used an /ʌ/ vowel instead of a schwa /ə/. A similar phenomenon occurs in item 2, second syllable. Here the child used /o/ instead of the correct schwa. Contrast this incorrect production with that of item 3, in which the child correctly used a schwa in the second syllable. I propose as an initial hypothesis that only highly familiar polysyllabic words will have reduced syllables; "Sesame Street" certainly ought to be familiar to most kids these days. Items 4, 5, and 6 show that these light syllables can appear in early utterances, even in light initial syllables, as in items 4 and 6. Though the initial syllable did not appear in item 5, a correctly reduced syllable did occur after the accented syllable. Finally, item 7 shows two light syllables, the first of which was incorrectly produced as the heavy form /tu/, the second of which is reduced to just a short interconsonantal schwa.

The next five items illustrate syllable deletion, which may possibly be the step just prior to syllable reduction; that is, deletion may be a stronger, earlier, form of reduction. In item 8, for example, the underlined syllables have coalesced into one. In item 9, however, the phenomenon appears to be deletion rather than coalescence. That is, the child apparently said "Donner Blitzen" rather than "Donnern Blitzen". This process occurs twice in item 10; note that the /b/ and the high front glide appeared in the child's rendition of "somebody", indicating again a coalescence, rather than simply a deletion, whereas the second syllable of "opening" appears to have been deleted. Item 11 was a reasonably articulate production of "sandwiches", as an answer to the question "What does your daddy like to eat?" However, in item 12, an answer to "What kind of sandwiches?", only a generally nasalized sibilant remained of the last two syllables.

The next set of examples illustrate how the child deals with what I assume to be his problem of producing a changing pitch contour within a single syllable. As Vanderslice and Ladefoged (1972) point out, the final intonation contour begins on the last accented syllable of the phrase. If that syllable also happens to be phrase final, then the entire contour must occur during that one vocalic nucleus, which therefore becomes very long. There was a huge difference in the lengths of the two /au/ vowels of "around" in item 13. The second "around", in final position, was much longer than the first. Item number 14 starts with an answer to the question "Who's Captain Hook?", with a very long /ɔ/ in "dog". Then, in answer to the further question "What kind of dog?", the accent shifted contrastively to "pirate", the intonation contour began on "pi-", and "dog" was only minimally lengthened. I think it is fair to say, however, that the first "dog" was too long; that is, although an adult would use a very long vowel, and although the child appears to both understand and deal with the problem of placing a pitch contour on a single syllable, he did not do it with the fluency of an adult. One might even argue that the child doubled the final vowel so as to be able to change pitches between its two parts. Finally, item 15 shows that if the pitch does not change, then

the final accented syllable is not overly lengthened. That is, with a sustained pitch contour, there is only enough vocalic lengthening to signal a pause.

These examples are but a sketchy beginning of what I believe will be a gradual unfolding of new ideas on how children acquire adult-like rhythm. It is especially satisfying and exciting, however, to be at the beginning, rather than nowhere at all.

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